UCRL-11586

University of California

Ernest O. Lawrence Radiation Laboratory

HYPERFINE-STRUCTURE SEPARATIONS AND MAGNETIC MOMENTS OF GOLD-194, 195, AND 196

TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 5545

Berkeley, California

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

To be published in Physical Review.

UCRL-11586

UNIVERSITY OF CALIFORNIA

Lawrence Radiation Laboratory
Berkeley, California

AEC Contract No. W-7405-eng-48

HYPERFINE-STRUCTURE SEPARATIONS AND MAGNETIC MOMENTS OF GOLD-194, 195, AND 196

Yau Wa Chan, W. Bruce Ewbank
William A. Nierenberg, and Howard A. Shugart

July 30, 1964

Hyperfine-Structure Separations and Magnetic Moments of Gold-194, 195, and 196

Yau Wa Chan†, W. Bruce Ewbank‡,
William A. Nierenberg, and Howard A. Shugart

Department of Physics and Lawrence Radiation Laboratory
University of California, Berkeley, California

July 30, 1964

ABSTRACT

The hyperfine-structure separations in the $^2S_{\frac{1}{2}}$ electronic ground state of 39-h Au^{194}, 185-d Au^{195}, and 6.2-d Au^{196} have been measured by the atomic-beam magnetic-resonance method. From these measurements combined with the known constants of Au^{197}, the corresponding nuclear magnetic-dipole moments were calculated by means of the Fermi-Segrè formula. A 5% error is assigned in these moments to include a possible hyperfine-structure anomaly correction. The results are:

	$\Delta\nu$ (Mc/sec)		μ_I (nm)(uncorr.)
Au^{194}	±3489.865(32)		±0.073(4)
Au^{195}	±6220(38)		±0.146(7)
Au^{196}	+23,100(2200)	for	+0.58(3)
	or -24,700(2600)	for	-0.62(3)

I. INTRODUCTION

The nuclear spins of 39-h Au^{194}, 185-d Au^{195}, and 6.2-d Au^{196} are known to be $I = 1$, $3/2$, and 2 respectively.[1,2] The hyperfine-structure (hfs) separations of these isotopes in the $^2S_{\frac{1}{2}}$ electronic ground state have now been measured by the atomic-beam magnetic-resonance technique employing the "flop-in" principle.[3] From the measured hfs separations, we have calculated the nuclear magnetic moments of these isotopes, using the known properties of Au^{197} for comparison.

II. GENERAL PRINCIPLES

For free atoms of gold in the $^2S_{\frac{1}{2}}$ electronic ground state, the interaction of the nucleus with the valence s electron is limited to the magnetic-dipole contact interaction. This interaction splits the J level into two hyperfine levels, which are labeled by the corresponding total angular momentum $F = I \pm \frac{1}{2}$, where I is the nuclear spin. In the presence of an external magnetic field H, each F level splits into 2F+1 magnetic sublevels labeled with magnetic quantum numbers m_F. For $J = \frac{1}{2}$, the energy of these (F, m_F) levels is described analytically by the Breit-Rabi formula,[4] which may be written, in units of $h\Delta\nu$, as

$$\frac{W(F, m_F, x)}{h\Delta\nu} = -\frac{1}{2(2I+1)} - \frac{g_I}{g_I - g_J} m_F x + (F - I)\left(1 + \frac{4m_F}{2I+1} x + x^2\right)^{\frac{1}{2}}, \qquad (1)$$

where $x = (-g_J + g_I)(\mu_0 H/h\Delta\nu)$ and the positive root is taken. Here $g_J = \mu_J/J$ and $g_I = \mu_I/I$ are the electronic and nuclear g factors, μ_J and μ_I are expressed in Bohr magnetons, μ_0 is the magnitude of the Bohr magneton, and $h\Delta\nu$ is the hfs separation energy at zero magnetic field. The value of g_I

involved in this calculation is not known a priori. However, since $\Delta\nu$ is proportional to g_I, it may be estimated, when the hyperfine structure and nuclear moment of another isotope of the same element are known, by applying the Fermi-Segrè formula[5]

$$\frac{|g_I|}{|g_I'|} = \frac{|\Delta\nu|}{|\Delta\nu'|}\frac{(2I'+1)}{(2I+1)}. \qquad (2)$$

The smallness of terms in g_I ($g_I \approx \pm g_J/2000$) makes it convenient to calculate the value of $\Delta\nu$ and g_I by solving Eqs. (1) and (2) simultaneously. Since the algebraic sign of g_I cannot be determined in this experiment, two values of $\Delta\nu$ have been calculated--one for a positive moment and one for a negative moment. The final value of $\Delta\nu$ is obtained as the average of these two calculations if they do not differ significantly.

A typical energy-level diagram corresponding to Eq. (1) for $I = 2$, and $\mu_I > 0$ is shown in Fig. 1. The low-frequency transitions that may be observed in the atomic-beam apparatus are shown on the diagram. All these observable transitions have $F = I + \frac{1}{2}$ and involve the level with $m_F = -(I + \frac{1}{2})$. A transition may be induced by absorption of k quanta of radiation, leading to a state with $m_F = -(I + \frac{1}{2}) + k$. A multiple quantum transition of order k (a k-quantum transition) is caused by simultaneous absorption or emission of k quanta of radiation.[6]

III. PRODUCTION OF SAMPLES

Gold-194, 195, and 196 were produced at the Berkeley Crocker Laboratory's 60-in. cyclotron by the reactions Pt(d, kn) Au, for $k = 1$ and 2. A 20-mil natural platinum foil was bombarded with 24-MeV deuterons for 12

to 24 h. A standard chemical procedure with ethyl acetate was used to separate the radioactive gold from the platinum target.[7] A pure metallic gold sample was obtained with about 60 mg of stable gold carrier.

In the work with Au^{194}, the target was processed immediately after cyclotron irradiation. Because high relative specific activity of the isotope under investigation is desired for optimum results, the Au^{196} target was stored for about 1 week (until most of the 39-h activity of Au^{194} had decayed). A target for the study of Au^{195} was usually stored for at least a month before use.

IV. EXPERIMENTAL PROCEDURE

The atomic-beam magnetic-resonance apparatus and the general procedure employed for these measurements have been discussed elsewhere,[8,9] so they are described only briefly here.

The gold sample was contained inside a tantalum oven lined with a carbon cup and having a carbon cap and carbon snout. Electron bombardment heated the oven to provide the beam of atoms. The radioactive beam was detected by collecting the radioactive atoms on sulfur-coated collector buttons. After exposure, each button was counted in x-ray scintillation counters containing 1 mm-thick NaI(Tl) crystals. All counting rates for each resonance button were corrected for counter background, for fluctuation of beam intensity, and for radioactive decay when necessary. The transition magnetic field was calibrated by observing the "standard transition" (ν_0 in Fig. 1) in Rb^{85} and Rb^{87} beams which were detected on a surface-ionization detector. Transition radiofrequencies were obtained with equipment described previously.[9] Radiofrequencies were generated and measured with enough accuracy to produce no significant error in the final results.

All data of each isotope were analyzed by computer programs to obtain the best-fit value of $\Delta\nu$ according to the method of least-squares. The nuclear magnetic dipole moment of each isotope was calculated from Eq. (4) by comparison with recent measurements on Au^{197}.[10] In order to allow for a possible hfs anomaly, a 5% error is assigned to magnetic dipole moments calculated from Eq. (4). The quoted moments are not corrected for diamagnetic shielding.

V. RESULTS FOR Au^{194}

Several resonances of the "standard transition" in Au^{194} have been observed at magnetic fields up to 638 G. Calculations from these resonances gave a preliminary value of $\Delta\nu$ = 3503(10) Mc/sec, in agreement with the earlier measurement [$\Delta\nu$ = 3600(120) Mc/sec] given by W. H. Hooke et al.[11] With this value, a search for $\Delta F = \pm 1$ transitions was feasible. The experimental results of the hfs Zeeman spectrum are shown in Fig. 2. In Fig. 3, the magnetic-field-independent ($\partial\nu/\partial H \approx 0$) transition, $(3/2, 1/2) \leftrightarrow (1/2, -1/2)$, was carefully observed at two different rf power levels. This test seems to indicate that the unexplained splitting of the resonance line is not due to the magnitude of the rf power.

A summary of Au^{194} results is shown in Table I. To allow for the possibility of systematic errors in the apparatus, we take the uncertainty assigned (here and elsewhere in this paper) for the value of $\Delta\nu$ to be twice that given by the least-squares analysis. The final results are $\Delta\nu = \pm 3489.865(32)$ Mc/sec and μ_I (uncorr.) = $\pm 0.073(4)$ nm.

VI. RESULTS FOR Au^{195}

Because of the long half-life of Au^{195} (185 days), the activity produced by a cyclotron bombardment is very low. The success of producing a good

sample of Au^{195} usually depends on how long a given Pt target can be used without being burned through by the 70-to 80-μA deuteron beam. The practical difficulty in producing Au^{195} samples suggested that the normal experimental procedure might be altered slightly to conserve material. The nuclear spins[2,12,13] of Au^{191}, Au^{193}, Au^{197}, and Au^{199} are the same as that of Au^{195}, $I = 3/2$; and the corresponding hfs separations are, respectively, $\Delta\nu \approx 5780$, 5890,[14] 6099, and 11,000 Mc/sec.[13] It was suspected therefore, that the $\Delta\nu$ of Au^{195} might be some value between the $\Delta\nu$ of Au^{193} and Au^{197}. By assuming that $\Delta\nu \approx 6000$ Mc/sec, a resonance of the standard transition was first attempted and observed for Au^{195} at a magnetic field of 273 G. A later resonance, observed at 528 G, is shown in Fig. 4. A summary of all resonances is given in Table I. The calculated values are $\Delta\nu = \pm 6220(38)$ Mc/sec and μ_I (uncorr.) $= \pm 0.146(7)$ nm.

VII. RESULTS FOR Au^{196}

Several resonances of $I = 2$ with $\Delta F = 0$ were observed at magnetic fields lower than 75 G for Au^{196}. All these resonance frequencies show no appreciable shift from the Zeeman frequency for $I = 2$. This suggests that the $\Delta\nu$ of Au^{196} might be large. The resonance observed at a magnetic field of 84 G is shown in Fig. 5. A calculation from the small frequency shift, $\nu - \nu_\infty \approx 0.17$ Mc/sec, indicated initially that $\Delta\nu$ could be as large as 65,000 Mc/sec. However, in the present atomic-beam apparatus, the magnitudes of the refocusing A and B magnetic fields about 3500G; hence it is not possible to observe a standard transition for an isotope with $I = 2$ and $\Delta\nu \geqslant 16,000$ Mc/sec. Consequently, the resonance observed could not be due to the standard transition. In this situation, the $\Delta\nu$ of Au^{196} may be measured either by increasing the A and B magnetic fields or by looking for multiple-quantum

transitions. Since we could not increase substantially the A and B fields, the multiple-quantum transition method was chosen. In order to observe multiple-quantum transitions, a high rf transition field is necessary in the structure (hairpin) that impresses the rf on the beam. A tunable coupling unit was connected between the hairpin and the output of the rf amplifier to improve current transfer.

The spectrum of multiple-quantum transitions terminating at the level $m_F = -(I+\frac{1}{2})$ is labeled in Fig. 1. In Fig. 6, one of the resonance sweeps is shown. The observed resonances are identified as due to 2-quantum and 3-quantum transitions by comparing them with the corresponding transitions in Au^{198}, which has the same spin and a similar hfs. A summary of results is given in Table I. The final calculated results are $\Delta\nu = +23.1(22)$ kMc/sec with μ_I(uncorr.) = +0.58(3) nm, or $\Delta\nu = -24.7(26)$ kMc/sec with μ_I(uncorr.) = -0.62(3) nm.

VIII. COMMENTS

The magnetic moment of Au^{195} is nearly the same as those of Au^{191}, Au^{193}, and Au^{197} and probably arises from the 79th proton in a $d_{3/2}$ shell.

The similarity of the spins (I = 2) and of the magnetic moments of Au^{196} and Au^{198} suggests that the shell assignments and couplings in these isotopes are also the same. The magnetic moments are consistent with a ground-state configuration $(\pi\, d_{3/2})(\nu\, p_{1/2})$ as proposed by Christensen et al.[15]

Removal of two neutrons from Au^{196} (I = 2), however, causes the ground-state spin to change to I = 1, with an accompanying change in magnetic moment. The simple shell model is not able to give a reasonable explanation for the spin I = 1 for these nuclei. Although Hooke attempted to analyze the magnetic moment of odd-odd gold nuclei by using a collective model with a strongly

deformed core, the results have not been satisfactory for those nuclei with $I = 1$.[16]

ACKNOWLEDGMENTS

We wish to thank the personnel of the late 60-inch Crocker Cyclotron for their assistance with many bombardments and of the Health Chemistry Division of the Lawrence Radiation Laboratory for overseeing the safe handling of radioactive materials.

FOOTNOTES AND REFERENCES

* This research was supported by the U. S. Office of Naval Research and the U. S. Atomic Energy Commission.

† Present address: Physics Division, Brookhaven National Laboratory, Upton, Long Island, N. Y.

‡ Present address: Nuclear Data Group, National Research Council, Oak Ridge National Laboratory, Oak Ridge, Tenn.

1. J. B. Reynolds, R. L. Christensen, W. H. Hooke, D. R. Hamilton, H. H. Stroke, W. B. Ewbank, W. A. Nierenberg, H. A. Shugart, and H. B. Silsbee, Bull. Am. Phys. Soc. 2, 347 (1957).
2. W. B. Ewbank, L. L. Marino, W. A. Nierenberg, H. A. Shugart, and H. B. Silsbee, Phys. Rev. 115, 644 (1959).
3. J. R. Zacharias, Phys. Rev. 61, 270 (1942).
4. G. Breit and I. I. Rabi, Phys. Rev. 38, 2082 (1931).
5. E. Fermi and E. Segrè, Z. Physik 82, 729 (1933).
6. M. N. Hack, Phys. Rev. 104, 84 (1956).
7. Y. W. Chan, W. B. Ewbank, W. A. Nierenberg, and H. A. Shugart, Phys. Rev. 127, 572 (1962).
8. J. P. Hobson, J. C. Hubbs, W. A. Nierenberg, H. B. Silsbee, and R. J. Sunderland, Phys. Rev. 104, 101 (1956).
9. Y. W. Chan, W. B. Ewbank, W. A. Nierenberg and H. A. Shugart, Phys. Rev. 133, B1138 (1964); W. B. Ewbank and H. A. Shugart, Phys. Rev. 129, 1617 (1963).
10. S. Penselin, University of Heidelberg, Heidelberg, Germany, private communication (June 1963); also E. Recknagel, Z. Physik 159, 19 (1960).

11. W. H. Hooke, R. L. Christensen, D. R. Hamilton, J. B. Reynolds, and H. H. Stroke, Bull. Am. Phys. Soc. 2, 344 (1957).

12. R. M. Elliot and J. Wolf, Phys. Rev. 55, 170 (1939).

13. R. L. Christensen, D. R. Hamilton, A. Lemonick, F. M. Pipkin, J. B. Reynolds, and H. H. Stroke, Phys. Rev. 101, 1389 (1956).

14. W. B. Ewbank and H. A. Shugart, Phys. Rev. 135 A358 (1964).

15. R. L. Christensen, D. R. Hamilton, A. Lemonick, F. M. Pipkin, J. B. Reynolds and H. H. Stroke, Phys. Rev. 101, 1389 (1956).

16. W. M. Hooke, Phys. Rev. 115, 453 (1959).

Table I. Summary of resonances for gold-194, 195, and 196.[a]

Gold isotope	Calibration frequency (Mc/sec) Rb^{85}	Calibration frequency (Mc/sec) Rb^{87}	H (G)	Transition quantum numbers F_1 m_1		F_2 m_2	$\nu_{obs.}$[b] (Mc/sec)	Frequency residual (kc/sec)
Au^{194}	10.114(30)	15.067(30)	21.354(95)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{3}{2}$ $-\frac{3}{2}$	20.190(100)	+2
	12.675(30)	18.750(30)	26.594(65)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{3}{2}$ $-\frac{3}{2}$	25.260(150)	+51
	22.562(30)	33.100(30)	46.625(65)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{3}{2}$ $-\frac{3}{2}$	44.655(60)	-24
	55.255(30)	78.610(30)	108.646(55)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{3}{2}$ $-\frac{3}{2}$	107.640(100)	+20
	57.080(30)	81.170(10)	112.001(95)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{3}{2}$ $-\frac{3}{2}$	111.090(200)	-52
	122.640(40)	164.850(50)	219.998(90)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{3}{2}$ $-\frac{3}{2}$	231.120(200)	-48
	391.920(50)	----	533.965(46)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{3}{2}$ $-\frac{3}{2}$	657.150(300)	-115
	----	545.000(100)	637.308(97)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{3}{2}$ $-\frac{3}{2}$	823.600(400)	+602
	----	545.350(50)	637.648(49)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{3}{2}$ $-\frac{3}{2}$	823.950(300)	+386
	516.680(50)	548.327(50)	640.532(50)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{3}{2}$ $-\frac{3}{2}$	828.000(300)	-366
	1.385(10)	----	2.961(21)	$\frac{3}{2}$ $\frac{3}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $\frac{1}{2}$	3495.200(100)	-203
	1.445(10)	----	3.088(21)	$\frac{3}{2}$ $\frac{3}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $\frac{1}{2}$	3495.500(100)	-143
	2.090(10)	3.106(10)	4.448(30)	$\frac{3}{2}$ $\frac{3}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $\frac{1}{2}$	3498.100(100)	-89
	2.110(10)	3.128(10)	4.485(30)	$\frac{3}{2}$ $\frac{3}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $\frac{1}{2}$	3498.300(200)	+41
	2.303(10)	3.421(10)	4.899(35)	$\frac{3}{2}$ $\frac{3}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $\frac{1}{2}$	3499.100(100)	+65
	2.128(10)	3.167(10)	4.532(30)	$\frac{3}{2}$ $\frac{1}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $\frac{1}{2}$	3494.600(200)	+479
	2.295(10)	3.408(10)	4.881(35)	$\frac{3}{2}$ $\frac{1}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $\frac{1}{2}$	3494.600(100)	+149
	1.519(10)	2.229(10)	3.215(40)	$\frac{3}{2}$ $\frac{1}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $-\frac{1}{2}$	3489.883(30)	+8
	1.520(10)	----	3.217(40)	$\frac{3}{2}$ $\frac{1}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $-\frac{1}{2}$	3489.883(30)	+8
	1.521(10)	2.234(10)	3.220(40)	$\frac{3}{2}$ $\frac{1}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $-\frac{1}{2}$	3489.883(30)	+8
	2.281(10)	3.387(10)	4.851(35)	$\frac{3}{2}$ $\frac{1}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $-\frac{1}{2}$	3489.900(100)	+12
	2.288(10)	3.398(10)	4.867(35)	$\frac{3}{2}$ $-\frac{1}{2}$	$\leftrightarrow$	$\frac{1}{2}$ $-\frac{1}{2}$	3485.100(100)	-239

Table I. (continued)

Gold isotope	Calibration frequency (Mc/sec) Rb^{85}	Rb^{87}	H (G)	Transition quantum numbers F_1 m_1			F_2 m_2	$\nu_{obs.}$ [b] (Mc/sec)	Frequency residual (kc/sec)
Au^{195}	159.108(50)	207.929(50)	272.886(60)	2	-1	⟷	2 -2	210.160(200)	+114
	358.930(40)	411.960(20)	502.789(30)	2	-1	⟷	2 -2	419.250(300)	+ 34
	385.919(50)	436.463(30)	528.387(40)	2	-1	⟷	2 -2	444.350(400)	-157
Au^{196}	88.288(10)	122.062(10)	165.703(20)	$\frac{5}{2}$	$-\frac{1}{2}$	⟷	$\frac{5}{2}$ $-\frac{5}{2}$	188.000(200)	- 44
	88.288(10)	122.062(10)	165.703(20)	$\frac{5}{2}$	$\frac{1}{2}$	⟷	$\frac{5}{2}$ $-\frac{5}{2}$	281.010(300)	+87
	88.277(10)	122.030(10)	165.673(20)	$\frac{5}{2}$	$-\frac{1}{2}$	⟷	$\frac{5}{2}$ $-\frac{5}{2}$	187.950(200)	- 59
	88.277(10)	122.030(10)	165.673(20)	$\frac{5}{2}$	$\frac{1}{2}$	⟷	$\frac{5}{2}$ $-\frac{5}{2}$	280.875(300)	+ 3
	84.915(10)	117.728(20)	160.105(25)	$\frac{5}{2}$	$-\frac{1}{2}$	⟷	$\frac{5}{2}$ $-\frac{5}{2}$	181.600(350)	- 17
	84.915(10)	117.728(20)	160.105(25)	$\frac{5}{2}$	$\frac{1}{2}$	⟷	$\frac{5}{2}$ $-\frac{5}{2}$	271.530(300)	+170

a. Results:

Isotope	I	$\Delta\nu$ (Mc/sec)	μ_I (uncorr.) (nm)	χ^2	
Au^{194}	1	±3489.865(32)	±0.073(4)	25	(22 observations)
Au^{195}	$\frac{3}{2}$	+6218(38)	+0.146(7)	0.5	(3 observations)
		-6223(38)	-0.146(7)	0.5	
Au^{196}	2	+23100(2200)	+0.58(3)	0.5	(6 observations)
		-24700(2600)	-0.62(3)	0.3	

b. For Au^{196}, $\nu_{obs.}$ is multiplied by a factor k, the order of the multiple-quantum transition.

FIGURE LEGENDS

Fig. 1. An energy-level diagram for an atom with $J = 1/2$ and $I = 2$. The flop-in, multiple-quantum transitions shown all involve the $(5/2, -5/2)$ level.

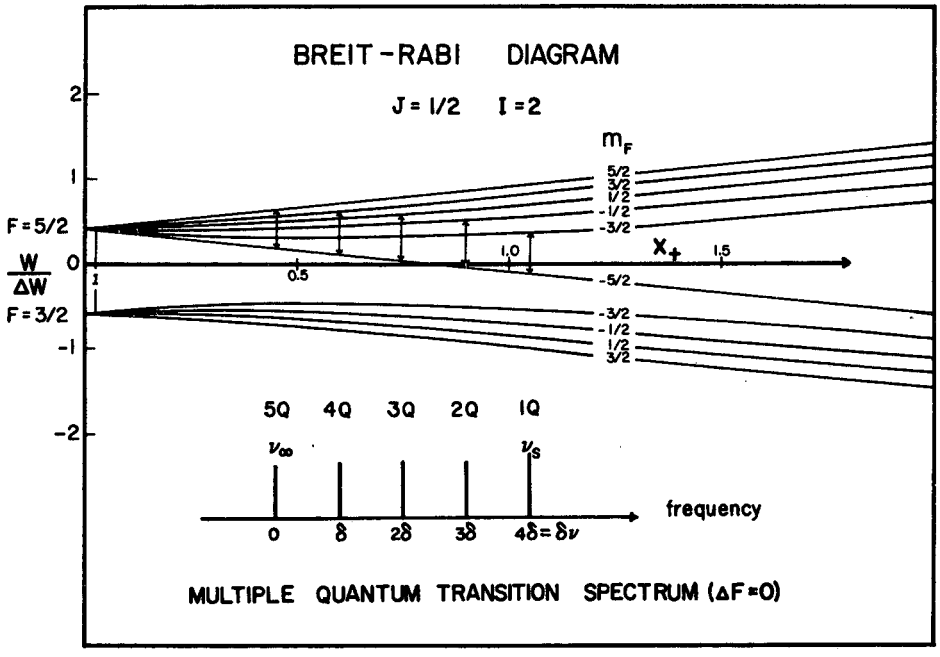
Fig. 2. The observed direct ($\Delta F = \pm 1$) transitions in 39-h Au^{194}.

Fig. 3. A $\Delta F = \pm 1$ field-independent resonance at two rf power levels.

Fig. 4. The "standard" flop-in transition in 185-d Au^{195}.

Fig. 5. The $\Delta F = 0$ transition in 6.2-d Au^{196} at 84G.

Fig. 6. Two- and three-quantum transitions in 6.2-d Au^{196}.



MU-27401

Fig. 1

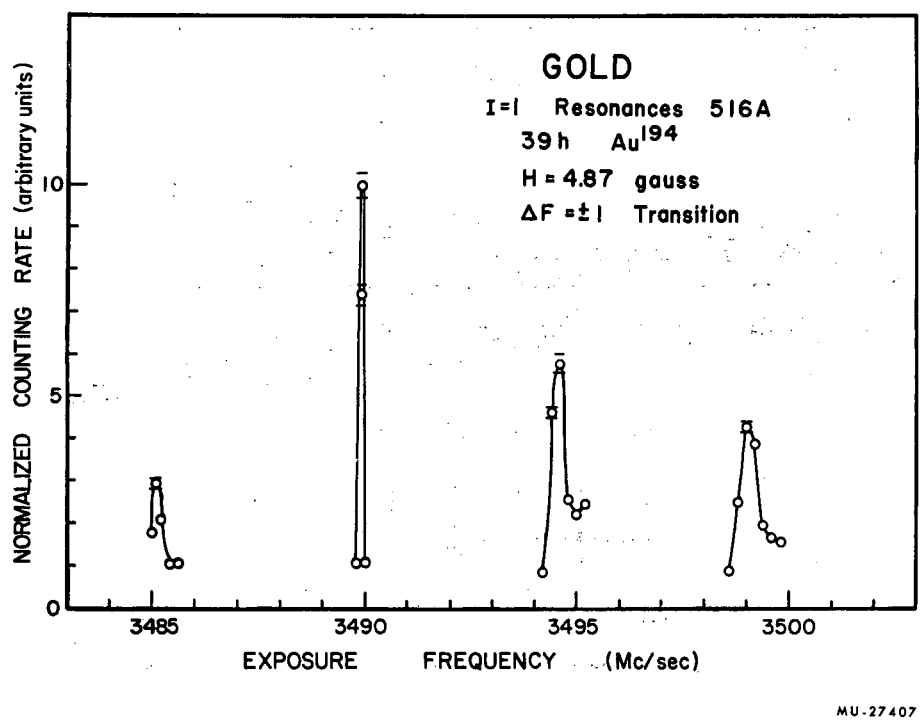
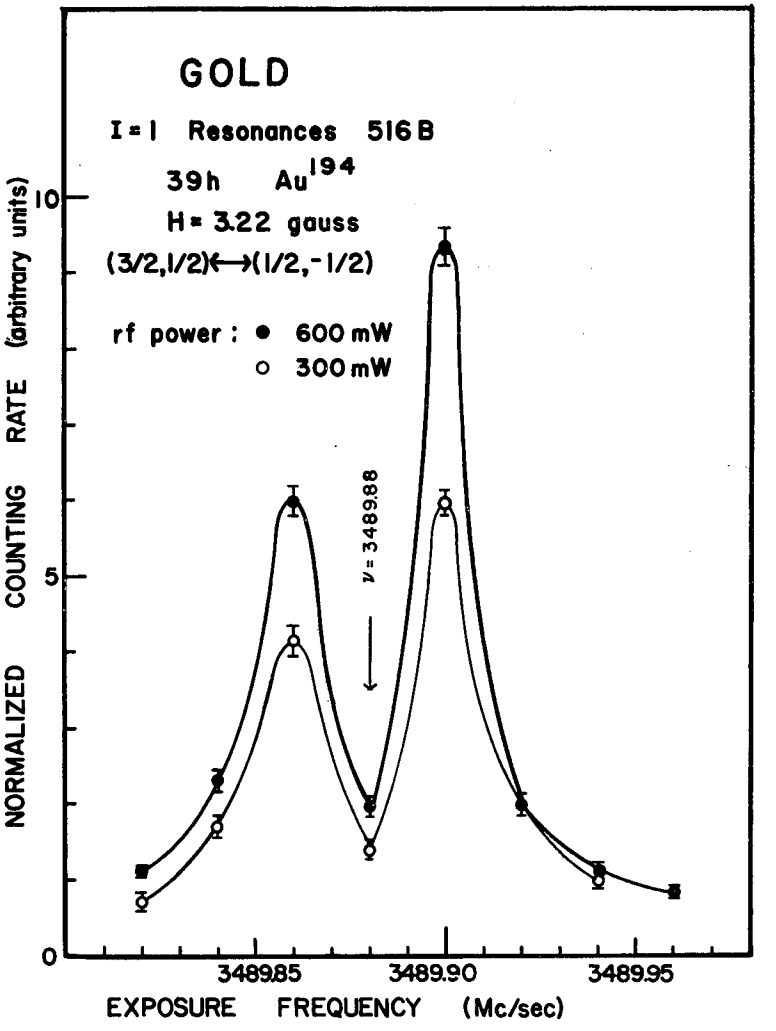

GOLD
I=1 Resonances 516A
39 h Au194
H = 4.87 gauss
ΔF = ± 1 Transition
NORMALIZED COUNTING RATE (arbitrary units)
0
5
10
3485
3490
3495
3500
EXPOSURE FREQUENCY (Mc/sec)
MU-27407

Fig. 2



MU-27408

Fig. 3

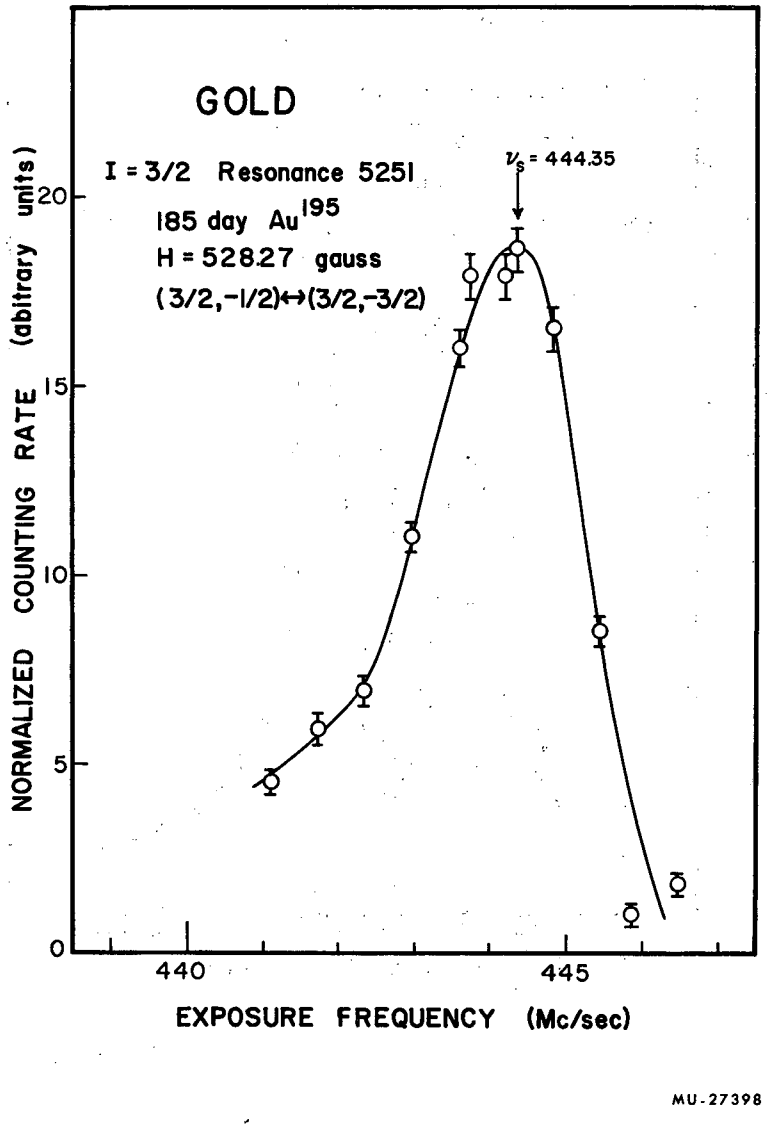

GOLD
I = 3/2 Resonance 5251
185 day Au195
H = 528.27 gauss
(3/2,-1/2)↔(3/2,-3/2)
ν_s = 444.35
NORMALIZED COUNTING RATE (abitrary units)
0
5
10
15
20
440
445
EXPOSURE FREQUENCY (Mc/sec)
MU-27398

Fig. 4

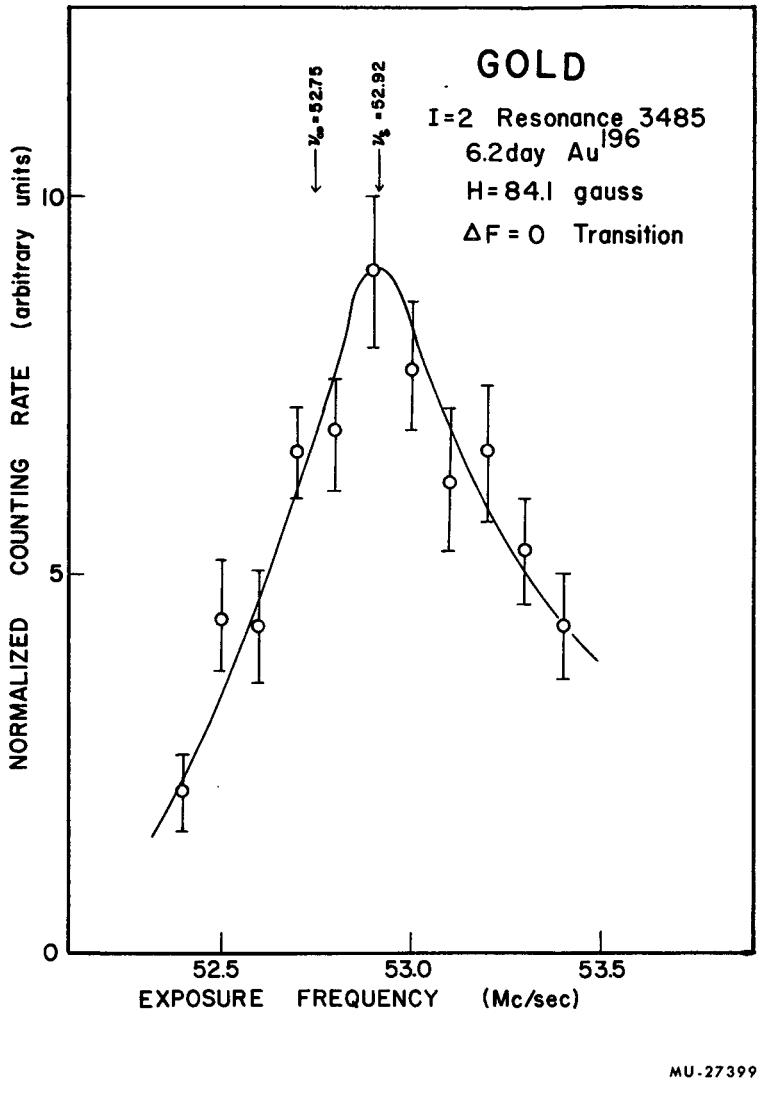

GOLD
I=2 Resonance 3485
6.2day Au196
H=84.1 gauss
ΔF = 0 Transition
ν∞ =52.75
νb =52.92
NORMALIZED COUNTING RATE (arbitrary units)
10
5
0
52.5
53.0
53.5
EXPOSURE FREQUENCY (Mc/sec)
MU-27399

Fig. 5

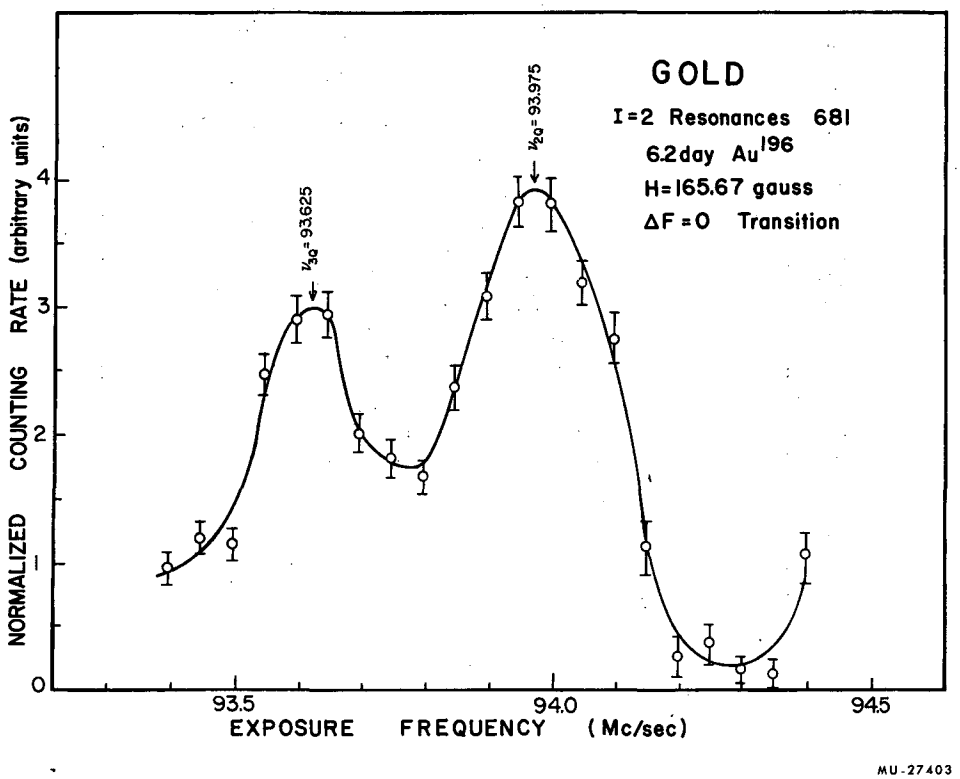

GOLD
I=2 Resonances 681
6.2day Au196
H=165.67 gauss
ΔF=0 Transition
ν3a=93.625
ν2a=93.975
NORMALIZED COUNTING RATE (arbitrary units)
0
1
2
3
4
93.5
94.0
94.5
EXPOSURE FREQUENCY (Mc/sec)
MU-27403

Fig. 6

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.